Serial No. RD-26,782/USA

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Mark Philip D'Evelyn et al. :

Serial No.: : Group Art Unit:

Filed: : Examiner:

For: SURFACE IMPURITY-ENRICHED DIAMOND AND METHOD OF MAKING : Paper No.: 1

PRELIMINARY AMENDMENT

Assistant Director of Patents and Trademarks
United States Patent and Trademark Office
Washington, DC 20231

Sir:

Please amend the continuation submitted herewith of Application Serial No. 09/225,914, filed January 5, 1999, as follows.

If any additional fees for the accompanying response are required, Applicant requests that this be considered a petition therefor. The Director is hereby authorized to charge any fees that may be required to Deposit Account 07-0868.

In the Specification:

On page 1, line 2, please insert the following:

--This is a continuation of Application Serial No. 09/225,914, filed January 5, 1999.--

In the Claims:

Please cancel Claims 2, 10-12, 14, 15, 19, and 22, without prejudice.

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Marked-up versions of amended Claims 1, 3, 8, 13, 16, 20, and 23 are provided in Attachment A.

Please substitute the following for pending Claim 1:

1. (Amended) A three-dimensional faceted synthetic diamond crystal for use in a tool, the diamond crystal comprising at least one dopant element, the dopant element being selected from the group consisting of boron, nitrogen, hydrogen, lithium, nickel, cobalt, sodium, potassium, aluminum, phosphorous, oxygen, and combinations thereof, and having a greater concentration toward or near an outermost surface of the diamond crystal than in the center of the diamond crystal, wherein the concentration of the dopant element is at a local minimum at least about 5 micrometers below the surface,

wherein the concentration of the dopant element causes an expansion of the diamond lattice toward or near the outermost surface of the diamond crystal, thereby generating tangential compressive stresses at the surface of the crystal, the tangential compressive stresses being in the range of between about 10 to about 5000 megapascals (MPa);

and wherein the generation of tangential compressive stresses increases the compressive fracture strength of the diamond, as compared to a diamond crystal in which the diamond lattice is not substantially expanded.

Please substitute the following for pending Claim 3:

3. (Amended) The diamond crystal of claim 1, wherein the dopant element is selected from the group consisting of boron, nitrogen, hydrogen, and mixtures of any of the foregoing.

Please substitute the following for pending Claim 8:

8. (Amended) The diamond crystal according to claim 1, wherein the dopant element concentration within an outermost section of about 3 to about 50 micrometers of the crystal is in an amount of about 40 to about 10,000 parts per million.

Please substitute the following for pending Claim 13:

13.(Amended) The diamond crystal of claim 1, wherein the increase in compressive fracture strength is at least about 2%.

Please substitute the following for pending Claim 16:

16. (Amended) The diamond crystal of claim 1, wherein the diamond crystal has a diameter of up to about 2 centimeters.

Please substitute the following for pending Claim 20:

20. (Amended) The diamond crystal of claim 1, further comprising a coated film of doped diamond about 3 to about 50 micrometers thick on an outer surface of the diamond crystal, wherein the concentration of the dopant element in the coated film is about 40 to about 10,000 parts per million greater than the concentration of the dopant element in the outer surface of the underlying diamond crystal.

Please substitute the following for pending Claim 23:

23. (Amended) A method of making a diamond crystal for use in a tool, the diamond crystal having a tangential compressive stress on a surface up to about 5000 megapascals, the method comprising the step of:

growing a three-dimensional diamond crystal by a High Temperature High Pressure process, wherein the diamond crystal includes impurities that enrich an outer surface of the diamond crystal in a concentration that is about 40 parts per million to about 10,000 parts per million, at a depth from the outer surface of about 3 micrometers to about 50 micrometers.

Please add the following new claims:

25. The diamond crystal of claim 1, wherein the concentration of the dopant element within the diamond lattice increases with increasing radius from the local minimum.

26. A tool comprising a plurality of diamond crystals embedded therein, wherein each of the plurality of diamond crystals has a diamond lattice and comprises at least one dopant element, wherein the dopant element is present in a concentration that causes the diamond lattice to expand toward or near an outermost surface of the crystal, thereby generating tangential compressive stresses at the surface of the crystal which increase the compressive fracture strength of the diamond crystal.

27. The tool of claim 26, wherein the tool is a tool selected from the group consisting of grinding wheels, dressing tools for grinding wheels, truing tools for grinding wheels, and saw blades.

28. A tool comprising a plurality of diamond crystals embedded therein, wherein each of the plurality of diamond crystals is a three-dimensional faceted synthetic diamond crystal having a diamond lattice and comprising at least one dopant element, the dopant element being selected from the group consisting of boron, nitrogen, hydrogen, lithium, nickel, cobalt, sodium, potassium, aluminum, phosphorous, oxygen, and combinations thereof, the dopant element being present in a concentration that is greater toward or near an outermost surface of the diamond crystal than in the center of the diamond crystal, the concentration of the dopant element having a local minimum at least about 5 micrometers below the surface,

wherein the concentration of the dopant element causes the diamond lattice to expand toward or near the outermost surface, thereby generating tangential compressive stresses in the range of between about 10 to about 5000 megapascals (MPa) at the surface of the crystal which increases the compressive fracture strength of the diamond crystal.

29. The tool of claim 28, wherein the dopant element is selected from the group consisting of boron, nitrogen, hydrogen, and combinations thereof.

30. The tool of claim 28, wherein the dopant element is boron, aluminum, or combinations thereof.

31. The tool of claim 30, wherein nitrogen is dissolved in the diamond crystal, and wherein the concentration of nitrogen exceeds the total concentration of dopant elements.

32. The tool of claim 31, wherein the concentration of nitrogen exceeds the total concentration of dopant elements by at least about 5 parts per million.

33. The tool of claim 28, wherein the dopant element is selected from the group consisting of nitrogen, hydrogen, nickel, cobalt, oxygen, and combinations thereof.

34. The tool of claim 28, wherein the dopant element concentration within an outermost section of about 3 to about 50 micrometers of the diamond crystal is in an amount of about 40 to about 10,000 parts per million.

35. The tool of claim 28, wherein the concentration of the dopant element is at a local maximum at a distance less than about 5 micrometers from the surface of the diamond crystal.

36. The tool of claim 28, wherein the increase in compressive fracture strength of the diamond crystal is at least about 2%.

37. The tool of claim 28, wherein the concentration of the dopant element within the diamond lattice increases with increasing radius from the local minimum crystal.

38. The tool of claim 28, wherein the diamond crystal has a diameter up to about 2 centimeters.

39. The tool of claim 28, wherein each of the plurality of diamond crystals is a single crystal.

40. The tool of claim 28, wherein each of the plurality of diamond crystals further comprises a coated film of doped diamond disposed on an outer surface of the diamond crystal, the coated film being about 3 to about 50 micrometers thick, wherein the concentration of the dopant element in the coated film is about 40 to about 10,000 parts

per million greater than the concentration of the dopant element in the outer surface of the underlying diamond crystal.

41. The tool of claim 40, wherein the dopant element is diffused into the diamond crystal, and the concentration of the dopant element is about 40 to about 10,000 parts per million at a depth of about 3 micrometers to about 50 micrometers within said diamond crystal.

42. The tool of claim 28, wherein the tool is a tool selected from the group consisting of grinding wheels, dressing tools for grinding wheels, truing tools for grinding wheels, and saw blades.

REMARKS

Applicants have submitted herewith a continuation of Application Serial No. 09/225,914, filed January 5, 1999, and respectfully request that the accompanying Preliminary Amendment be entered. In the continuation, Claims 1, 3, 8, 16, 20, 23, and 26 have been amended. Marked-up versions of the amended claims are provided in Attachment A. Claims 2, 10-12, 14, 15, 19, and 22, have been canceled, without prejudice, and new Claims 25-42 have been added in the present Amendment. As such, Claims 1, 3-9, 13, 16-18, 20, 21, 23, and 24, and new Claims 25-42 remain in the case.

The Examiner is invited to telephone the Applicants' counsel at the number provided below in order to resolve any outstanding issues concerning the present application.

Respectfully submitted,

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ATTACHMENT A

Assistant Director of Patents and Trademarks
United States Patent and Trademark Office
Washington, DC 20231

Sir:

Marked-up versions of amended Claims 1, 3, 8, 15, 16, 20, and 23 are provided below.

Marked-up version of Claim 1:

1. (Amended) A three-dimensional faceted synthetic diamond crystal for use in a tool, the diamond crystal comprising at least one dopant element, the dopant element being selected from the group consisting of boron, nitrogen, hydrogen, lithium, nickel, cobalt, sodium, potassium, aluminum, phosphorous, oxygen, and combinations thereof, and having [which has] a greater concentration toward or near an outermost surface of the diamond crystal than in the center of the diamond crystal, wherein the concentration of the dopant element is at a local minimum at least about 5 micrometers below the surface,

wherein the concentration of the dopant element causes an expansion of the diamond lattice toward or near the outermost surface of the crystal, thereby generating tangential compressive stresses at the surface of the diamond crystal, the tangential compressive stresses being in the range of between about 10 to about 5000 megapascals (MPa);

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and wherein the generation of tangential compressive stresses increases the compressive fracture strength of the diamond, as compared to a diamond crystal in which the diamond lattice is not substantially expanded.

Marked-up version of Claim 3:

3. (Amended) The diamond crystal of claim 1[2], wherein the dopant element is selected from the group consisting of boron, nitrogen, hydrogen, and mixtures of any of the foregoing.

Marked-up version of Claim 8:

8. (Amended) [A] The diamond crystal according to claim 1, wherein the dopant[-]element concentration within an outermost section of about 3 to about 50 micrometers of the diamond crystal is in an amount of about 40 to about 10,000 parts per million.

Marked-up version of Claim 13:

13. (Amended) The diamond crystal of claim 1[12], wherein the increase in compressive fracture strength is at least about 2%.

Marked-up version of Claim 16:

16. (Amended) The diamond crystal of claim 1 [15], [having] wherein the diamond crystal has a diameter of up to about 2 centimeters.

Marked-up version of Claim 20:

20. (Amended) The diamond crystal of claim 1 [15], further comprising a coated film of doped diamond about 3 to about 50 micrometers thick on an outer surface of the diamond crystal, wherein the concentration of the dopant element in the coated film is about 40 to about 10,000 parts per million greater than the concentration of the dopant element in the outer surface of [said] the underlying diamond crystal.

<u>Marked-up version of Claim 23:</u>

23. (Amended) A method of making a diamond crystal <u>for use in a tool, the diamond crystal</u> having a tangential compressive stress on a surface up to about 5000 megapascals, <u>the method</u> comprising the step of:

growing a three-dimensional diamond crystal by a High Temperature High Pressure process, wherein [said] <u>the diamond</u> crystal includes impurities that enrich an outer surface of the <u>diamond</u> crystal in a concentration that is about 40 parts per million to about 10,000 parts per million, at a depth from the outer surface of about 3 micrometers to about 50 micrometers.